US008208829B2

(12) **United States Patent**
Goda et al.

(10) **Patent No.: US 8,208,829 B2**
(45) **Date of Patent: Jun. 26, 2012**

(54) **IMAGE FORMING APPARATUS AND IMAGE FORMING UNIT**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 421 days.

(21) Appl. No.: **12/548,474**

(22) Filed: **Aug. 27, 2009**

(65) **Prior Publication Data**

US 2010/0054795 A1 Mar. 4, 2010

(30) **Foreign Application Priority Data**

Aug. 27, 2008 (JP) 2008-218229

(51) **Int. Cl.**
G03G 15/08 (2006.01)

(52) **U.S. Cl.** **399/102**; 399/346

(58) **Field of Classification Search** 399/102, 399/103, 157, 159, 274, 279, 286, 346
See application file for complete search history.

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(57) **ABSTRACT**

An image forming apparatus is provided with an image bearing member for bearing a toner image while rotating, a developing device including a developing roller for supplying toner to a surface of the image bearing member and a pair of gap rollers held in contact with opposite end portions of the image bearing member to define a specified gap between the developing roller and the surface of the image bearing member, and a lubricant applicator for applying a lubricant to parts of the opposite end portions of the image bearing member where the gap rollers are in contact.

9 Claims, 6 Drawing Sheets

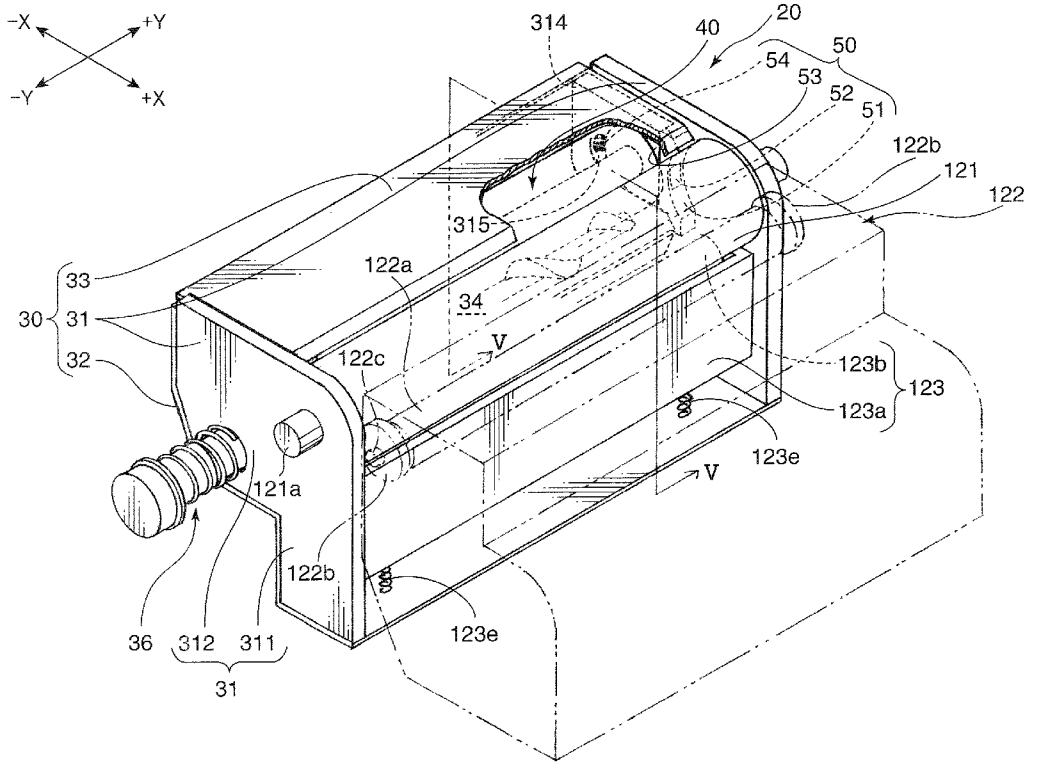


FIG. 1

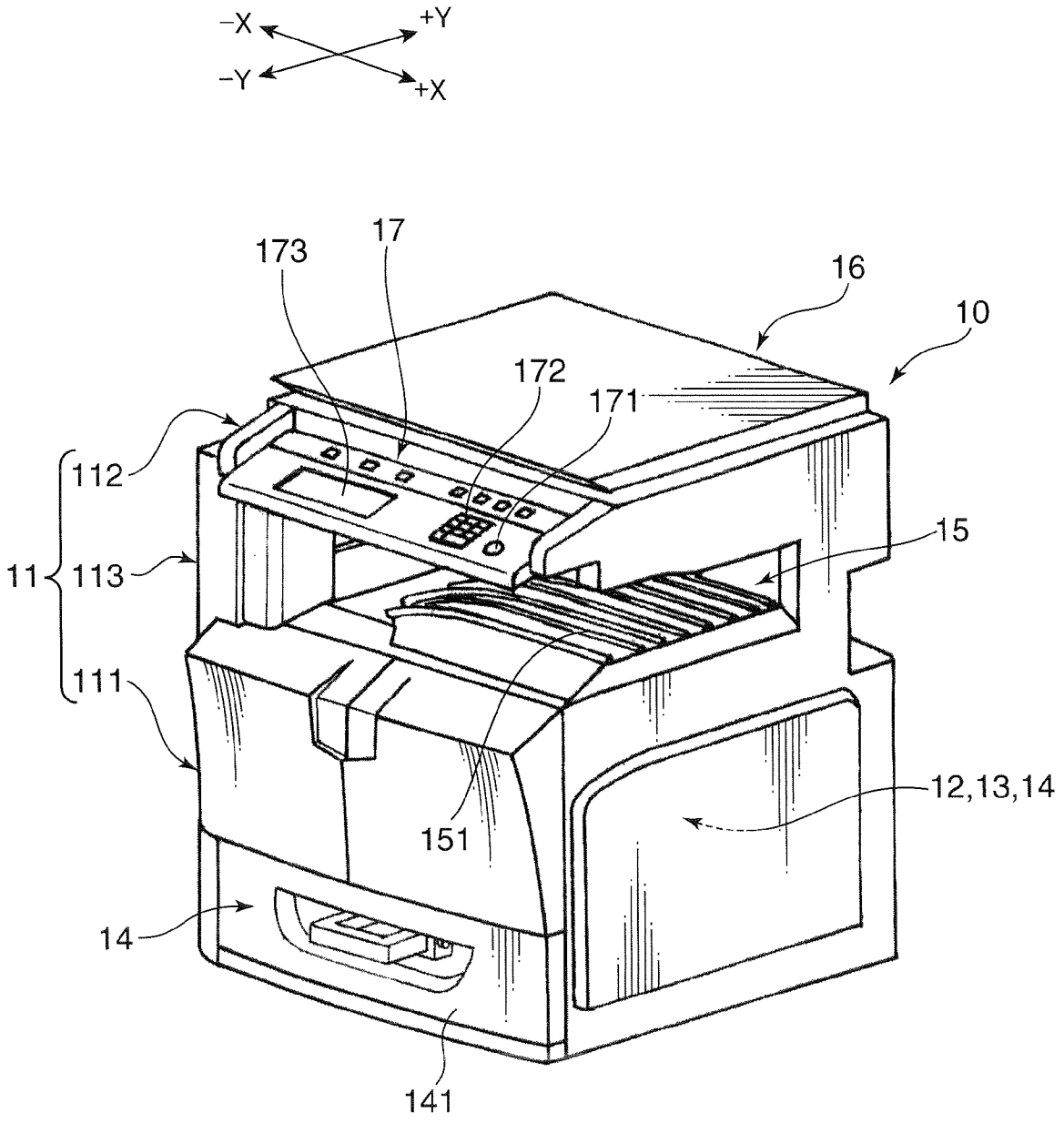
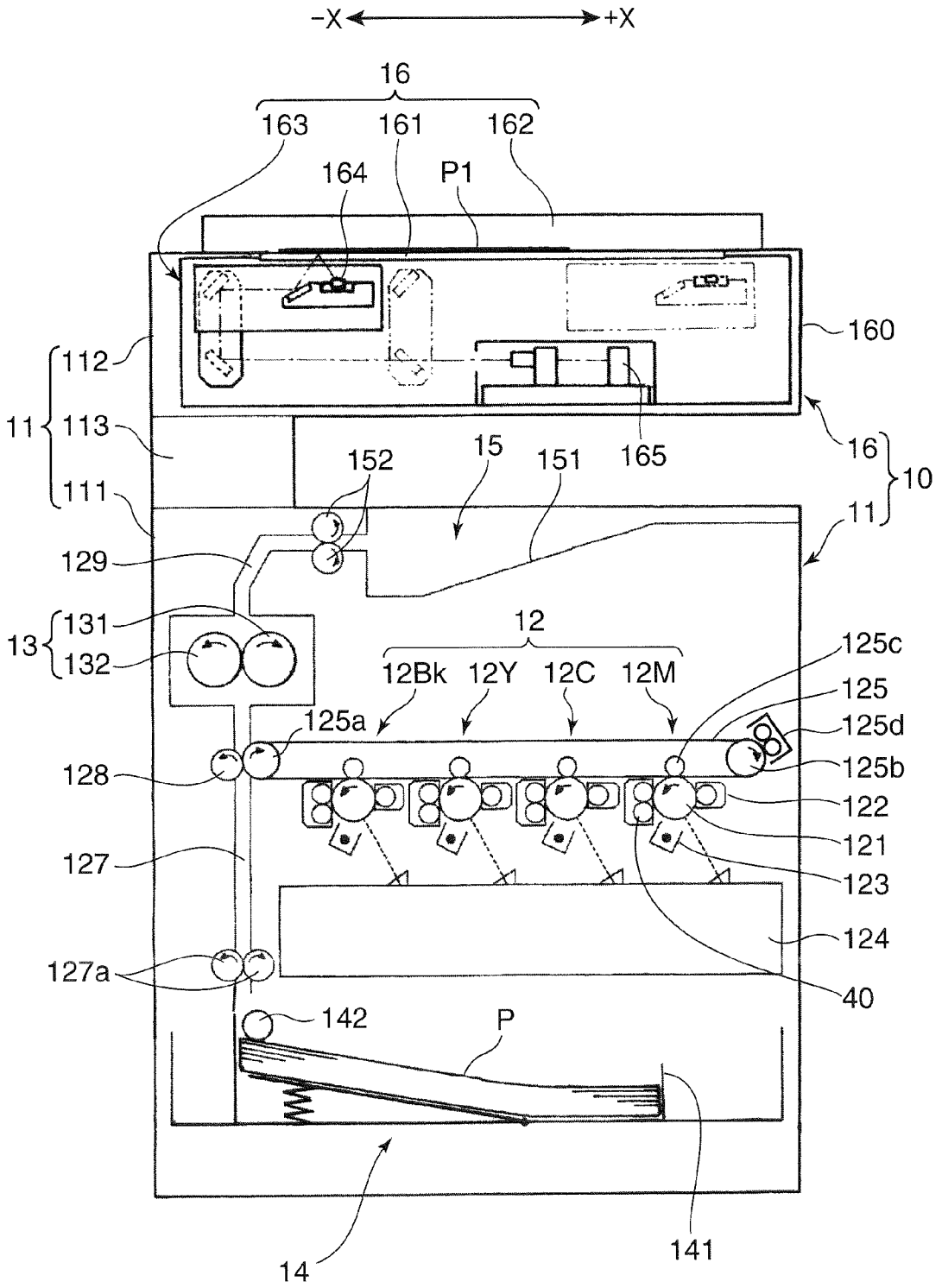


FIG. 2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131
13
132
12
12Bk
12Y
12C
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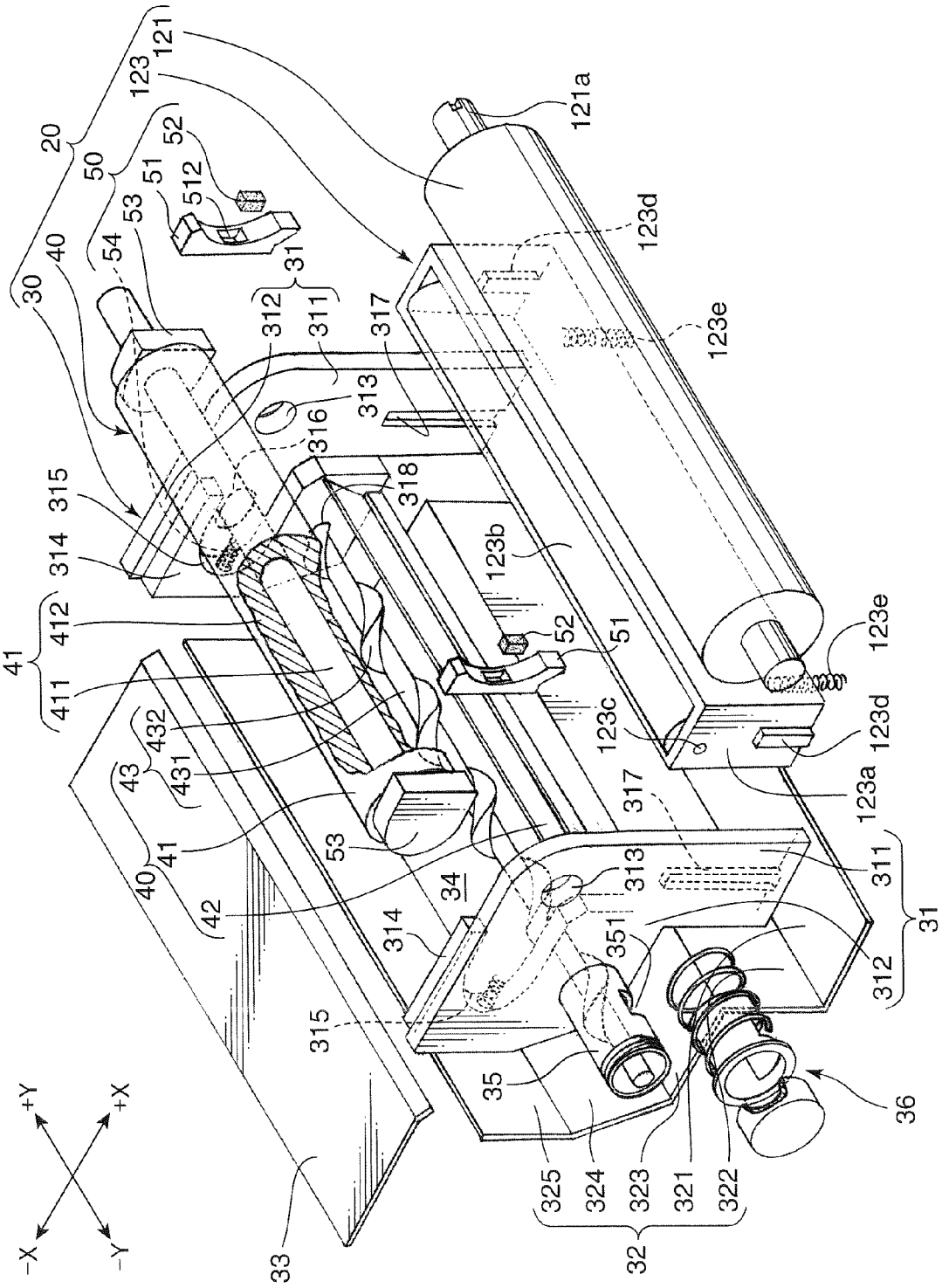
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123
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53
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31
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311
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123d
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318
315
314
123b
412
41
411
52
51
123e
123c
123d
432
43
431
123a
317
41
53
311
313
40
42
34
314
351
312
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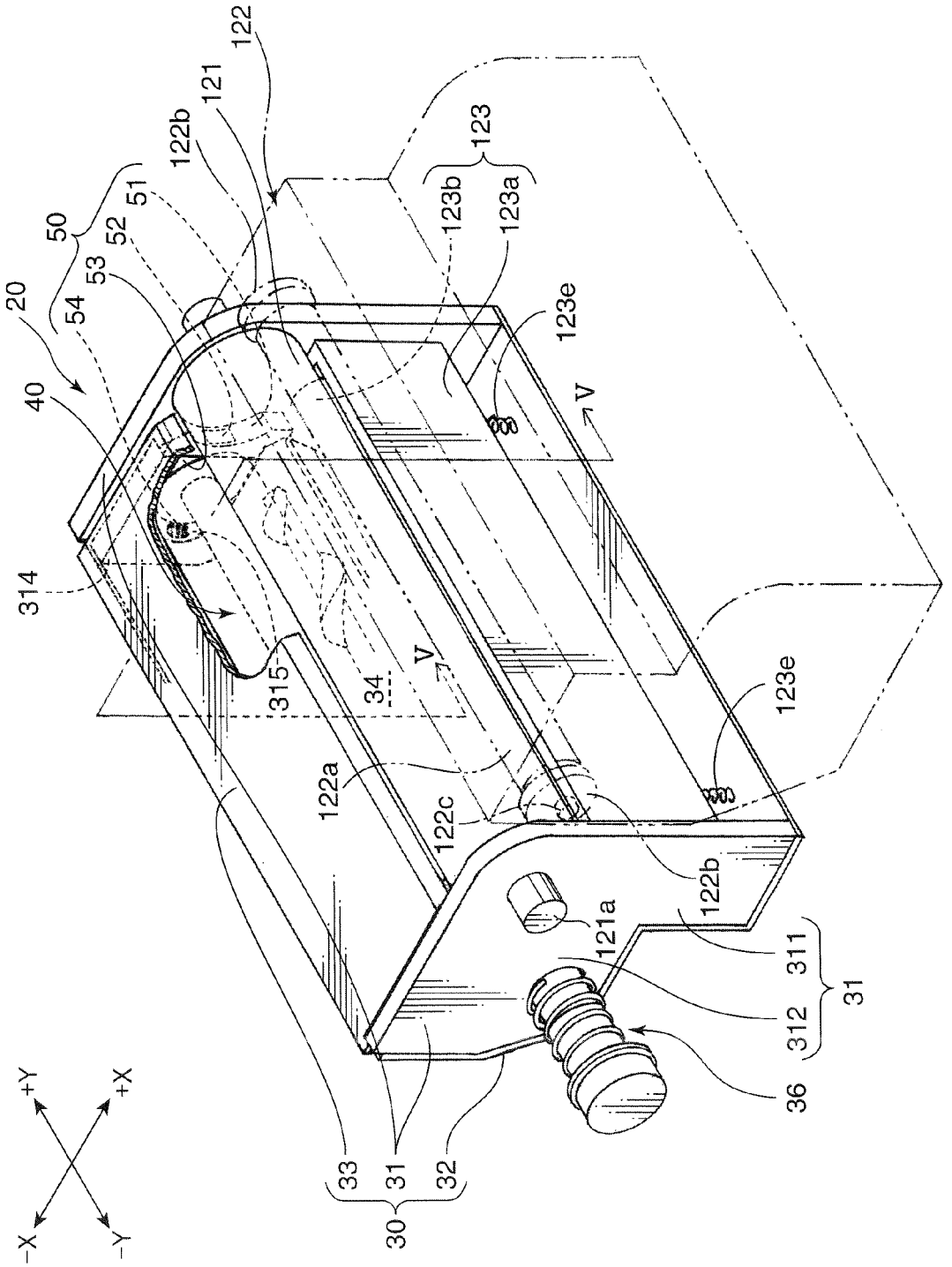
35
36
325
324
323
321
322
32
33
+Y
+X
-X
-Y

FIG. 3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315
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122c
121a
311
312
31
36
33
32
30
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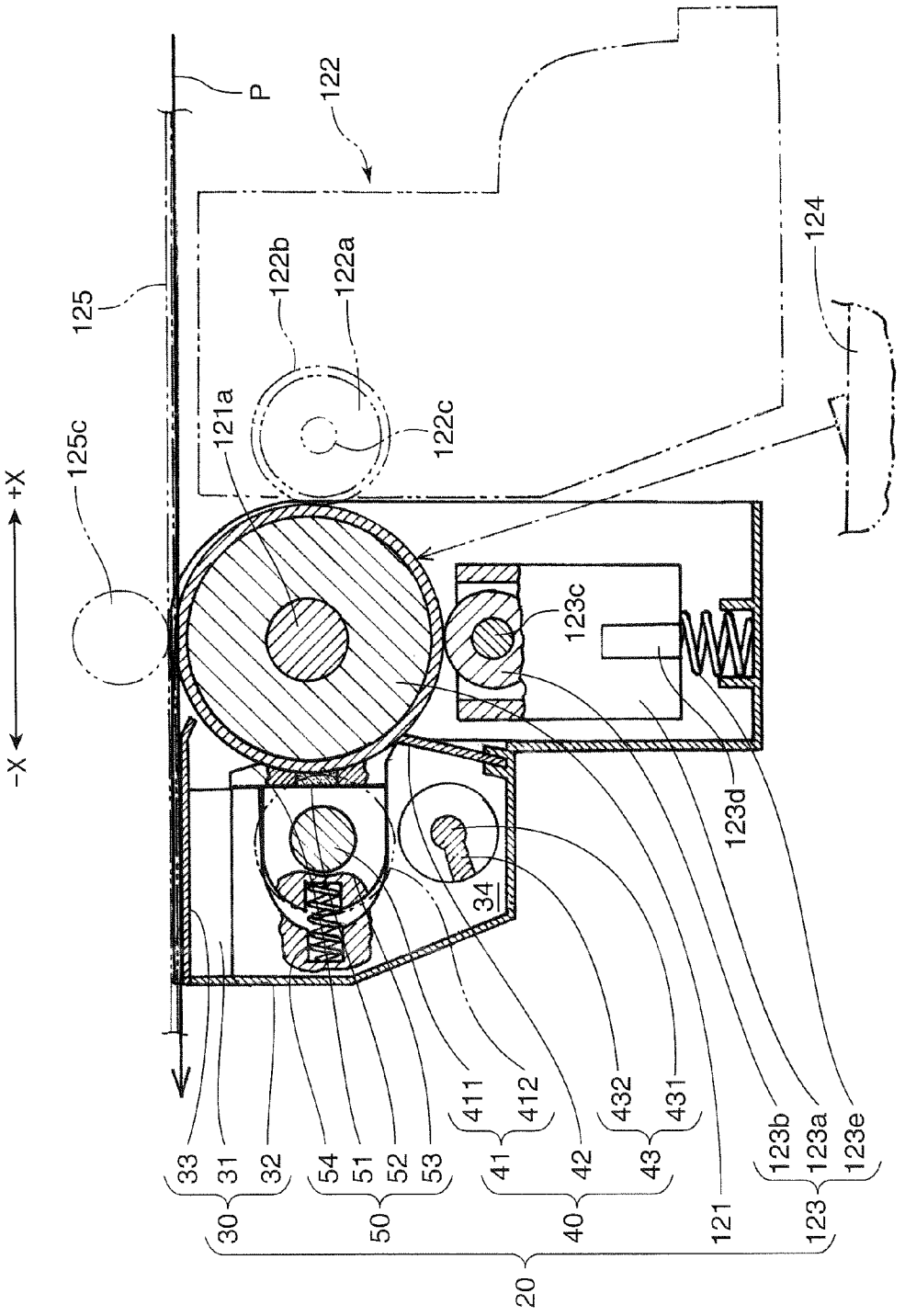
+X
-X
-Y

FIG. 4

FIG. 5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123
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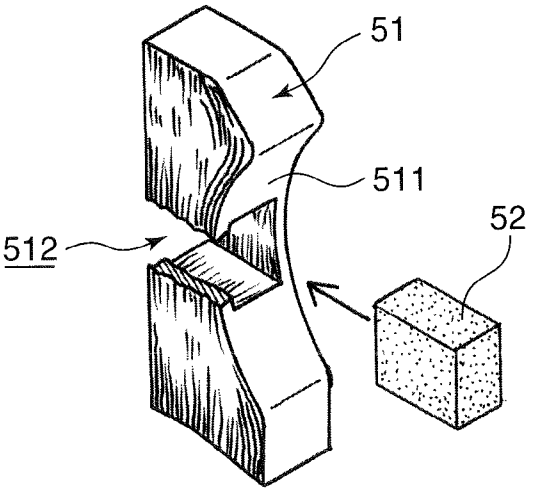
FIG. 6A



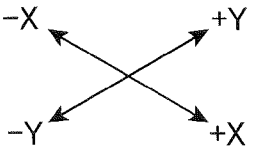


FIG. 6B

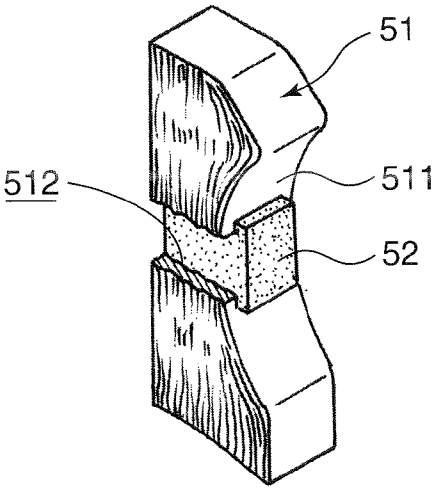


IMAGE FORMING APPARATUS AND IMAGE FORMING UNIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image forming apparatus provided with an image bearing member on the outer surface of which a toner image is to be formed, and an image forming unit employed in this image forming apparatus.

2. Description of the Related Art

There has been known an image forming apparatus constructed such that an electrostatic latent image is formed on the circumferential surface of a photoconductive drum (image bearing member) by reading a document image or based on image information transmitted from an external computer or the like, toner is supplied toward this electrostatic latent image from a developing device to form a toner image on the circumferential surface, and this toner image is transferred to a sheet.

In such an image forming apparatus, a proper image forming process is hindered in some cases due to residual toner remaining on the circumferential surface of the photoconductive drum after an image transferring process to a sheet and/or the deposition of nitrogen oxides produced during a high voltage charging process performed before an electrostatic latent image is formed on the circumferential surface.

In order to solve such problems, Japanese Unexamined Patent Publication No. 2006-259274 discloses an image forming apparatus provided with a coating bar made of a solid lubricant such as zinc stearate, wherein the lubricant from this coating bar is supplied to the circumferential surface of a photoconductive drum. In this apparatus, a fur brush driven to rotate is interposed between the coating bar and the photoconductive drum and the lubricant from the coating bar is applied to the circumferential surface of the image bearing member via this fur brush. Since frictional resistance of the circumferential surface of the photoconductive drum is reduced to make this circumferential surface lubricant by the application of the lubricant to the circumferential surface of the photoconductive drum, the deposition of foreign matters such as residual toner and nitrogen oxides is suppressed and an image failure caused by these extraneous matters is effectively prevented.

However, in the conventional image forming apparatus, the lubricant is mainly applied to an image formation region on the circumferential surface of the photoconductive drum. Thus, the deposition of foreign matters is prevented from this image formation region, but no consideration is made for the opposite end portions of the photoconductive drum not belonging to the image formation region.

In order to define tiny clearances (gaps) between the circumferential surface of a developing roller of a developing device and that of the photoconductive drum, gap rollers are in contact with the opposite end portions of the photoconductive drum in some cases. Thus, if extraneous matters are accumulated on the surfaces of the opposite end portions of the photoconductive drum, the gap rollers run onto and run off from these extraneous matters according to the rotation of the photoconductive drum, thereby varying a gap size. This makes toner supply to the circumferential surface of the photoconductive drum from the developing roller unstable, thereby presenting a problem of being unable to form a stable toner image on the circumferential surface of the photoconductive drum.

SUMMARY OF THE INVENTION

An object of the present invention is to constantly form a toner image on the circumferential surface of an image bearing member in a stable state.

One aspect of the present invention is directed to an image forming apparatus, including an image bearing member for bearing a toner image while rotating; a developing device including a developing roller for supplying toner to a surface of the image bearing member and a pair of gap rollers held in contact with opposite end portions of the image bearing member to define a specified gap between the developing roller and the surface of the image bearing member; and a lubricant applicator for applying a lubricant to parts of the opposite end portions of the image bearing member where the gap rollers are in contact.

These and other objects, features and advantages of the present invention will become more apparent upon a reading of the following detailed description with reference to accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing one embodiment of an image forming apparatus according to the invention,

FIG. **2** is a front view in section showing an internal construction of the image forming apparatus of FIG. **1**,

FIG. **3** is an exploded perspective view, partly cut away, showing one embodiment of a drum unit,

FIG. **4** is an assembled perspective view of the drum unit of FIG. **3**,

FIG. **5** is a section along V-V of FIG. **4**, and

FIGS. **6**A and **6**B are perspective views, partly cut away, showing one embodiment of a side sealing member, wherein FIG. **6**A shows a state before a lubricant is mounted in the side sealing member and FIG. **6**B shows a state where the lubricant is mounted in the side sealing member.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** is a perspective view showing one embodiment of an image forming apparatus **10** according to the present invention, and FIG. **2** is a front view in section showing an internal construction of the image forming apparatus **10**. In FIGS. **1** and **2**, X-X directions indicate leftward and rightward directions, wherein −X direction indicates leftward direction and +X direction indicates rightward direction, and Y-Y directions indicate forward and backward directions, wherein −Y direction indicates forward direction and +Y direction indicates backward direction.

The image forming apparatus **10** is a copier of the so-called internal discharge type and is provided with an apparatus body **11**, an image forming station **12**, a fixing unit **13**, a sheet storing unit **14**, a discharge unit **15**, an image reading unit **16** and an operation unit **17** which are all installed in the apparatus body **11**. The discharge unit **15** is formed by partly indenting the apparatus body **11** below the image reading unit **16**.

The apparatus body **11** includes a lower body **111** having a rectangular parallelepipedic outer shape, an upper body **112** having a flat rectangular parallelepipedic outer shape and facing the lower body **111** from above, and a connecting body **113** interposed between the upper and lower bodies **112**, **111**. The connecting body **113** is a structure for connecting the lower and upper bodies **111**, **112** with each other with the discharge unit **15** formed between the lower and upper bodies

111, 112, and stands from a left part of the lower body 111. The upper body 112 has a left part thereof supported on the upper end of the connecting body 113.

The image forming station 12, the fixing unit 13 and the sheet storing unit 14 are installed in the lower body 111, and the image reading unit 16 is installed in the upper body 112. The operation unit 17 project forward from a front edge portion of the upper body 112.

The discharge unit 15 is formed between the lower and upper bodies 111, 112 and includes an internal discharge tray 151 formed on the upper surface of the lower body 111. A sheet P having a toner image transferred thereto in the image forming station 12 is discharged from a lower part of the connecting body 113 toward this internal discharge tray 151.

The image forming station 12 is described below with reference to FIG. 2. The image forming station 12 is for forming a toner image on a sheet P fed from the sheet storing unit 14 and includes a magenta image forming part 12M, a cyan image forming part 12C, a yellow image forming part 12Y and a black image forming part 12Bk successively arranged from an upstream side (right side) toward a downstream side as shown in FIG. 2.

Each of the image forming parts 12M, 12C, 12Y and 12Bk includes a photoconductive drum (image bearing member) 121 and a developing device 122. Toner is supplied to each photoconductive drum 121 from a corresponding developing device 122 while the photoconductive drum 121 is rotated in a counterclockwise direction in FIG. 2. Each developing device 122 is replenished with toner from an unillustrated corresponding toner cartridge arranged at a front side of the apparatus body 111 (front side with respect to the plane of FIG. 2).

Chargers 123 are disposed at positions right below the respective photoconductive drum 121, and exposure devices 124 are disposed at positions further below the respective chargers 123. The circumferential surfaces of the respective photoconductive drums 121 are uniformly charged by the chargers 123. The respective exposure devices 124 irradiate laser beams corresponding to the respective colors based on image data read by the image reading unit 16 to the charged circumferential surfaces of the photoconductive drums 121, thereby forming electrostatic latent images on the circumferential surfaces of the photoconductive drums 121. Toners are supplied from the developing devices 122 to such electrostatic latent images, whereby toner images are formed on the circumferential surfaces of the photoconductive drums 121.

A transfer belt 125 is so arranged at a position above the photoconductive drums 121 as to be held in contact with the respective photoconductive drums 121. This transfer belt 125 is mounted between a drive roller 125*a* disposed at a left position of FIG. 2 and a driven roller 125*b* disposed at a right position of FIG. 2. Such a transfer belt 125 is rotated between the drive roller 125*a* and the driven roller 125*b* in synchronism with the respective photoconductive drums 121 while being pressed against the circumferential surfaces of the photoconductive drums 121 by transfer rollers 125*c* disposed in correspondence with the respective photoconductive drums 121.

Accordingly, as the transfer belt 125 is rotated, a magenta toner image is transferred to the outer surface of the transfer belt 125 by the photoconductive drum 121 of the magenta image forming part 12M and, successively, a cyan toner image is transferred to the same position of the transfer belt 125 in a superimposition manner by the photoconductive drum 121 of the cyan image forming part 12C. Thereafter, a yellow toner image and a black toner image are similarly successively transferred in a superimposition manner by the yellow image forming part 12Y and the black image forming part 12Bk. In this way, a color image is formed on the outer surface of the transfer belt 125. The color image formed on the outer surface of the transfer belt 125 is transferred to a sheet P conveyed from the sheet storing unit 14.

A drum cleaner 40 for cleaning the circumferential surface of the photoconductive drum 121 by removing residual toner is disposed at a position to the left of each photoconductive drum 121 in FIG. 2. The circumferential surface of the photoconductive drum 121 cleaned by the drum cleaner 40 heads for the charger 123 for a new charging process. Waste toner removed from the circumferential surface of the photoconductive drum 121 by the drum cleaner 40 is collected into an unillustrated toner collection bottle via a specified path.

A vertically extending sheet conveyance path 127 is provided at a position to the left of the image forming station 12. A pair of conveyor rollers 127*a* are disposed at a specified position of this sheet conveyance path 127, and a sheet P from the sheet storing unit 14 is conveyed toward the transfer belt 125 mounted on the drive roller 125*a* by driving this pair of conveyor rollers 127*a*.

A second transfer roller 128 held in contact with the outer surface of the transfer belt 125 is disposed at a position of the sheet conveyance path 127 facing the drive roller 125*a*. The sheet P is pressed between the transfer belt 125 and the second transfer roller 128 while being conveyed along the sheet conveyance path 127, whereby the toner image on the transfer belt 125 is transferred to the sheet P.

A belt cleaner 125*d* for removing residual toner remaining on the outer surface of the transfer belt 125 is disposed to the right of the transfer belt 125. The transfer belt 125 having finished with the transferring process to the sheet P is rotated for a next transferring process after being cleaned by having the residual toner on the outer surface removed by this belt cleaner 125*d*.

The fixing unit 13 is for fixing the toner image transferred in the image forming station 12 to the sheet P and includes a fixing roller 131 internally fitted with an electrical heating element such as a halogen lamp as a heat source inside, and a pressure roller 132 arranged to face the fixing roller 131 from the left side. The sheet P finished with the transferring process and introduced from the image forming station 12 via the second transfer roller 128 is subjected to a fixing process of fixing the toner image thereto by a heating process by the fixing roller 131 while being pressed between the fixing roller 131 and the pressure roller 132.

The color printed sheet P finished with the fixing process passes along a discharge conveyance path 129 extending upward from the fixing unit 13 to be discharged toward the internal discharge tray 151 via a pair of discharge rollers 152.

The sheet storing unit 14 includes a sheet tray 141 detachably mounted at a position below the exposure devices 124 in the apparatus body 11. A bundle of sheets is stored in the sheet tray 141, and the sheets P are dispensed one by one from this bundle of sheets by driving a pickup roller 142 and introduced to the image forming station 12 via the sheet conveyance path 127.

The image reading unit 16 includes a contact glass 161 which is mounted in an opening formed in the upper surface of the upper body 112 and on which a document P1 is placed with a document surface faced down, a document pressing mat 162 openable and closable with respect to the contact glass 161 to press the document placed on the contact glass 161 and an optical unit 163 installed in the upper body 112 to read a document image of the document P1 placed on the contact glass 161.

The optical unit **163** irradiates light from a light source **164** toward the document image from below via the contact glass **161** with the document placed on the contact glass **161** pressed by the document pressing member **162**. Reflected light from the document surface is introduced to a CCD (charge coupled device) **165**. The CCD **165** generates an analog image signal by photoelectrically converting the reflected light. This analog image signal is outputted to the exposure devices **124** of the image forming station **12** after being digitized.

The operation unit **17** is operated to enter various items (sheet size, number of sets to be processed, etc.) concerning the image forming process. As shown in FIG. **1**, a start key **171**, a numeric keypad **172** used to enter numerical information, an LCD (liquid crystal display) **173** for displaying input information actually entered using the numeric keypad **172**, error messages, etc. and the like are provided in the operation unit **17**.

In this embodiment, the photoconductive drum **121**, the charger **123**, the drum cleaner **40**, a lubricant applicator **50** to be described and the like are unitized into a drum unit (image forming unit) **20** in the image forming apparatus **10** constructed as above. The drum unit **20** is provided in each of the image forming parts **12**M, **12**C, **12**Y and **12**Bk. These respective four drum units **20** are structurally identical while differing only in the type of toner to be used. Such drum units **20** are described below with reference to FIGS. **3** to **5**.

FIG. **3** is an exploded perspective view, partly cut away, showing the drum unit **20**. FIG. **4** is an assembled perspective view of the drum unit **20**. FIG. **5** is a section along V-V of FIG. **4**. In FIGS. **3** to **5**, direction indication by X and Y is the same as in the case of FIG. **1** (−X: leftward, +X: rightward, −Y: forward, +Y: backward).

The drum unit **20** includes a housing **30**, the photoconductive drum **121**, the charger **123**, the drum cleaner **40** and the lubricant applicator **50** which are all housed in this housing **30**. The housing **30** includes a pair of front and rear side plates **31** having an inverted L-shaped front view when viewed in −Y direction, a connecting plate **32** connecting the left sides of this pair of side plates **31** and a ceiling plate **33** connecting the upper sides of the pair of side plates **31**.

Each side plate **31** includes a vertically extending plate **311** and a horizontally extending plate **312** extending to the left from a substantially upper half of the vertically extending plate **311**. A drum shaft fitting hole **313** is perforated at a right-upper position of each side plate **31**, into which a drum shaft **121***a* of the photoconductive drum **121** is fittable.

On facing surfaces of the horizontally extending plates **312** of the respective side plates **31**, thickened portions **314** are formed to bulge out in facing directions to have a specified thickness. Each thickened portion **314** is formed with a mounting recess **315** by making a leftward extending cut in the right end surface. Movable brackets **53** to be described later are so fitted into these mounting recesses **315** as to be laterally movable.

A laterally long oblong hole **316** is perforated at a position of the horizontally extending plate **312** of the rear side plate **31** corresponding to the mounting recess **315**. A roller shaft **411** to be described later is so fitted into this oblong hole **316** as to be slightly laterally movable.

Vertically extending mounting grooves **317** are formed in substantially lower halves of facing surfaces of the vertically extending plates **311** of the pair of side plates **31**. A pair of front and rear ribs **123***d* of the charger **123** to be described later are fitted into these mounting grooves **317**.

The charger **123** includes a casing **123***a* and a charging roller **123***b* housed in this casing **123***a* such that an upper part thereof slightly project. The casing **123***a* is in the form of a rectangular parallelepiped having an open upper surface and a length slightly shorter than an inner dimension between the respective vertically extending plates **311** of the pair of side plates **31**. The charging roller **123***b* is supported rotatably about a roller shaft **123***c* extending between the front and rear side plates of the casing **123***a*. A voltage is applied from an unillustrated power supply device to the charging roller **123***b*, whereby the circumferential surface of the photoconductive drum **121** held in contact with the circumferential surface of the charging roller **123***b* is charged.

The ribs **123***d* fittable into the respective mounting grooves **317** formed in the facing surfaces of the respective vertically extending plates **311** of the housing **30** while being held in sliding contact therewith are provided on the front and rear side plate of the casing **123***a*. Accordingly, by fitting the respective ribs **123***d* into the corresponding mounting grooves **317**, the charger **123** can be vertically moved while the ribs **123***d* are guided by the mounting grooves **317**.

A specified number of coil springs **123***e* are provided in a compressed state between a bottom plate **321** of the housing **30** and a bottom plate of the casing **123***a* of the charger **123***b*. The circumferential surface of the charging roller **123** is pressed into contact with that of the photoconductive drum **121** by biasing forces of the coil springs **123***e* with the charger **123** mounted between the front and rear side plates **31**.

The connecting plate **32** connects the pair of side plates **31** with each other and closes openings at the left and lower sides between the pair of side plates **31**. The connecting plate **32** is formed to have such a step shape as to extend along the left and bottom edges of the side plates **31** in a front view viewed in −Y direction.

Specifically, the connecting plate **32** is made up of the bottom plate **321** corresponding to the bottom edges of the vertically extending plates **311** of the side plates **31**, a lower left plate **322** standing up from the left edge of the bottom plate **321** and corresponding to a part of the vertically extending plates **311** below the horizontally extending plates **312**, a middle bottom plate **323** extending leftward from the upper edge of the lower left plate **322** along the bottom edges of the horizontally extending plates **312** of the side plates **31**, an inclined plate **324** extending from the left edge of the middle bottom plate **323** along oblique parts of the horizontally extending plates **312** of the side plates **31** at the left side, and an upper left plate **325** extending upward from the upper edge of the inclined plate **324**.

The housing **30** as shown in FIG. **4** is formed by fixing the connecting plate **32** with the left surfaces of the pair of side plates **31**, for example, using unillustrated screws and fixing the ceiling plate **33** to the upper edges of the respective thickened portions **314** of the horizontally extending plates **312** of the pair of side plates **31**, for example, using screws.

The drum cleaner **40** cleans the circumferential surface of the photoconductive drum **121** by removing extraneous matters from this circumferential surface. The extraneous matters include residual toner remaining on the circumferential surface of the photoconductive drum **121** after the transferring process to the sheet P and nitrogen oxides generated and deposited on the circumferential surface of the photoconductive drum **121** during high voltage application to this circumferential surface by the charger **123**.

The drum cleaner **40** includes a cleaning roller **41** extending between the respective thickened portions **314** of the pair of side plates **31**, a blade **42** disposed at a position right below the cleaning roller **41**, and a toner conveyance screw **43**

arranged between the blade **42** and the inclined plate **324** of the connecting plate **32** at a position right above the middle bottom plate **32**.

The cleaning roller **41** is rotated in a forward direction at a higher speed than the photoconductive drum **121** while the circumferential surface thereof is held in sliding contact with that of the photoconductive drum **121**, thereby removing extraneous matters deposited on the circumferential surface of the photoconductive drum **121**. The cleaning roller **41** includes the roller shaft **411** and a roller body **412** concentrically and integrally rotatably fitted on the roller shaft **411**. The roller shaft **411** is mounted in the housing **30** such that the front end of the roller shaft **411** is supported on the front movable bracket **53** mounted in the front mounting recess **315** and the rear end of the roller shaft **411** penetrates through the rear movable bracket **53** mounted in the rear mounting recess **315** and passes through the oblong hole **316**.

The pair of front and rear movable brackets **53** respectively fitted in the front and rear mounting recesses **315** are biased rightward by coil springs (biasing members) **54** to be described later, whereby the circumferential surface of the roller body **412** of the cleaning roller **41** is pressed into contact with that of the photoconductive drum **121**. By this press contact, extraneous matters on the circumferential surface of the photoconductive drum **121** are effectively removed. The extraneous matters removed from the circumferential surface of the photoconductive drum **121** are collected into an extraneous matter collecting space **34** enclosed by the horizontally extending plates **312** of the pair of side plates **31**, the middle bottom plate **323**, the inclined plate **324** and the blade **42**.

The blade **42** is disposed at the position right below the cleaning roller **41** to scrape off the extraneous matters on the circumferential surface of the photoconductive drum **121** that could not be removed by the drum cleaner **40**. The blade **42** is long in forward and backward directions (specifically has the same length as an inner dimension between the front and rear thickened portions **314**) and inclined upward toward the right so that the leading end thereof reaches the circumferential surface of the photoconductive drum **121** as shown in FIG. **5** with the base end thereof fixed to the right end of the middle bottom plate **323** of the connecting plate **32**.

The photoconductive drum **121** is rotated about the drum shaft **121***a* in a counterclockwise direction in FIG. **5**, whereby extraneous matters such as residual toner and nitrogen oxides adhering to the circumferential surface of the photoconductive drum **121** are scraped off by the leading end (upper end) of the blade **42**. In this way, an image formation region of the photoconductive drum **121** is cleaned. The extraneous matters scraped off from the circumferential surface of the photoconductive drum **121** are collected into the extraneous matter collecting space **34**.

The toner conveyance screw **43** discharges collected matters such as residual toner collected into the extraneous matter collecting space **34** to the outside. The toner conveyance screw **43** includes a screw shaft **431** extending between and penetrating through the respective thickened portions **314** of the pair of side plates **31**, and a spiral screw fin **432** concentrically and integrally rotatably fitted on the screw shaft **431** to carry the collected matters out by the rotation about the screw shaft **431**.

An insertion hole **318**, into which the rear end of the roller shaft **411** is inserted, is perforated in the thickened portion **314** of the rear side plate **31**, and a discharging tube body **35** for discharging the collected matters to an outer side (front side) is provided on the thickened portion **314** of the front side plate **31**. The front end of the toner conveyance screw **43** is inserted into this discharging tube body **35** and a discharge port **351** is formed at a specified position at the lower side of the discharging tube body **35**.

A specified shutter member **36** formed by combining a shutter mechanism, a spring and the like is mounted on the discharging tube body **35**. By mounting the drum unit **20** into the apparatus body **11**, the shutter member **36** interferes with a specified member in the apparatus body **11** to open the discharge port **351**. On the other hand, by pulling the drum unit **20** out from the apparatus body **11**, the interference between the specified member in the apparatus body **11** and the shutter member **36** is canceled to close the discharge port **351**.

The photoconductive drum **121**, the cleaning roller **41** and the toner conveyance screw **43** are linked with each other via unillustrated gears disposed between the drum shaft **121***a*, the roller shaft **411** and the screw shaft **431**. When a driving force of an unillustrated drive motor is, for example, transmitted to the drum shaft **121***a* to rotate the photoconductive drum **121** in the counterclockwise direction of FIG. **5**, this rotation is translated into a clockwise rotation of the cleaning roller **41** whose circumferential speed is set to be faster than that of the photoconductive drum **121** and a rotation of the toner conveyance screw **43** in a specified direction.

The developing device **122** shown by chain double-dashed line in FIGS. **4** and **5** includes a developing roller **122***a* for supplying the toner to the photoconductive drum **121** and gap rollers **122***b* arranged at the opposite ends of the developing roller **122***a*. The gap rollers **122***b* are provided to define a specified gap between the circumferential surface of the developing roller **122***a* and that of the photoconductive drum **121**. The gap rollers **122***b* and the developing roller **122***a* concentrically rotate. In other words, the developing roller **122***a* includes a rotary shaft **122***c* and the gap rollers **122***b* are mounted at the opposite end positions of this rotary shaft **122***c*.

The lubricant applicator **50** is for applying the lubricant to the circumferential surfaces of the opposite end portions of the photoconductive drum **121** lying outside the image formation region. The lubricant is applied to the circumferential surfaces of the opposite end portions of the photoconductive drum **121** for the following reason. Specifically, the circumferential surfaces of the opposite end portions of the photoconductive drum **121** lie outside the image formation region and, accordingly, residual toner is unlikely to adhere thereto. Thus, these circumferential surfaces are not cleaned by the drum cleaner **40**.

However, the gap rollers **122***b* are held in contact with the opposite end portions of the photoconductive drum **121** as shown in FIGS. **4** and **5**. Accordingly, if foreign matters such as residual toner and nitrogen oxides scattered to the opposite end portions of the photoconductive drum **121** adhere to and deposit on the opposite end portions of the photoconductive drum **121**, the gap rollers **122***b* run onto and, then, run off from the extraneous matters as the photoconductive drum **121** is rotated. This behavior causes the developing device **122** to swing.

If the developing device **122** swings, a strictly dimensioned gap size between the circumferential surface of the photoconductive drum **121** and that of the developing roller **122***a* changes. If the gap size changes, the toner cannot be supplied from the circumferential surface of the developing roller **122***a* toward that of the photoconductive drum **121** in a stable state, with the result that no proper toner image is formed on the circumferential surface of the photoconductive drum **121**, i.e. an image failure occurs. The lubricant applicator **50** applies the lubricant to the circumferential surfaces of the opposite

end portions of the photoconductive drum **121** in order to eliminate such an image failure. This reduces the frictional resistance of these circumferential surfaces to make them highly lubricant, thereby preventing the adhesion of foreign matters.

As shown in FIG. **3**, the lubricant applicator **50** includes side sealing members **51** held in contact with the circumferential surfaces of the opposite end portions of the photoconductive drum **121**, lubricants **52** held in the side sealing member **51**, the movable blocks **53** having the side sealing members **51** bonded to the right end surfaces thereof and functioning as bearings for the roller shaft **411**, and the coil springs **54** for biasing the movable brackets **53** toward the photoconductive drum **121**.

Although the side sealing members **51** are members for supporting the lubricants **52** in this embodiment, they are originally used to prevent the toner from leaking from the circumferential surface of the photoconductive drum **121**.

FIGS. **6**A and **6**B are perspective views, partly cut away, showing one embodiment of the side sealing member **51**, wherein FIG. **6**A shows a state immediately before the lubricant **52** is mounted into the side sealing member **51** and FIG. **6**B shows a state where the lubricant **52** is mounted in the side sealing member **51**. Direction indication by X and Y in FIGS. **6**A and **6**B is the same as in the case of FIG. **1** (−X: leftward, +X: rightward, −Y: forward, +Y: backward).

As shown in FIG. **6**A, the side sealing member **51** is formed by cutting a plurality of acrylic pile sealing materials (sheet-like sealing members made of an acrylic resin) laterally laminated using a specified adhesive while pressing them by a specified mold. An arcuate edge surface **511** to be held in sliding surface contact with the circumferential surface of the photoconductive drum **121** is formed in the right end surface of such a side sealing member **51**. A mount hole **512**, into which the lubricant **52** is fitted, is perforated in a central part of this arcuate edge surface **511**.

The lubricants **52** are abraded against the circumferential surfaces of the opposite end portions of the photoconductive drum **121** while being fitted in the mount holes **512** of the side sealing members **51** and lubricants solid at ordinary temperature are used. The lubricants **52** are shaped identical to the inner shape of the mount holes **512**, thereby being closely fitted into the mount holes **512**. Since the mount hole **512** is rectangular parallelepipedic in an example shown in FIG. **6**A, the lubricant **52** is set to have a rectangular parallelepipedic shape in conformity.

Metal salts of fatty acids such as palmitic acids, stearic acids or oleic acids are preferably used as such lubricants **52**. Since metal salts of such fatty acids are solid at ordinary temperature like solid soap and have slimy surfaces, they are suitable materials to be abraded to apply a lubricant component to the circumferential surface of the photoconductive drum **121**. As shown in FIG. **6**B, the lubricant **52** is so fitted in the mount hole **512** of the side sealing member **51** as to partly project from the arcuate edge surface **511**. This projecting part of the lubricant **52** is held in contact with the circumferential surface of the photoconductive drum **121**.

The respective movable brackets **53** are so fitted into the mounting recesses **315** formed in the thickened portions **314** of the respective side plates **31** as to be laterally movable while being held in sliding contact. The coil spring **54** is disposed between the left end surface of the movable bracket **53** and the left end surface of the mounting recess **315**. This coil spring **54** presses the movable bracket **53** rightward by its biasing force (see FIG. **5**).

The biasing forces of the coil springs **54** press the circumferential surface of the roller main body **412** into contact with the circumferential surface of the image formation region of the photoconductive drum **121** via the roller shaft **411** supported on the movable brackets **53**. Further, these biasing forces press the side sealing members **51** into contact with the respective circumferential surfaces of the opposite end portions of the photoconductive drum **121** via the movable brackets **53**. In this way, the lubricants **52** held in the respective side sealing members **51** are pressed into contact with the circumferential surfaces of the opposite end portions of the photoconductive drum **121**. Accordingly, when the photoconductive drum **121** is rotated about the drum shaft **121***a*, the lubricants **52** are abraded against the end portions of the photoconductive drum **121** to apply the lubricant component to these circumferential surfaces of the opposite end portions.

As described in detail above, the image forming apparatus **10** according to this embodiment includes the drum unit **20** for each toner color constructed by unitizing the photoconductive drum **121**, the charger **123**, the drum cleaner **40** and the lubricant applicator **50**. The lubricant applicator **50** applies the lubricants **52** to the opposite end portions of the photoconductive drum **121**.

According to such an image forming apparatus **10**, the lubricants **52** from the lubricant applicator **50** are applied to the opposite end portions of the photoconductive drum **121** to reduce the frictional resistance of the circumferential surfaces of the opposite end portions. This not only suppresses the adhesion of foreign matters such as residual toner and nitrogen oxides to these parts, but also makes foreign matters easily peelable even if they adhere. Thus, it can be suppressed that foreign matters are squeezed between the gap rollers **122***b* and the photoconductive drum **121**. Therefore, the problem that the gap size between the photoconductive drum **121** and the developing roller **122***a* changes to make the toner supply from the developing device **122** to the photoconductive drum **121** unstable can be prevented from occurring, with the result that the occurrence of an image failure can be prevented.

Since the lubricants **52** used are solid at ordinary temperature, they can be easily handled and the lubricant component can be easily applied according to the rotation of the photoconductive drum **121** simply by holding the solid lubricants **52** in contact with the circumferential surface of the photoconductive drum **121**. This contributes to the simplified structure of the lubricant applicator **50**.

Further, since the lubricants **52** are pressed against the circumferential surfaces of the opposite end portions of the photoconductive drum **121** by the biasing forces of the coil springs **54**, the lubricant component is applied to the circumferential surface of the photoconductive drum **121** as the photoconductive drum **121** is rotated. Accordingly, the lubricants **52** can be reliably applied to the photoconductive drum **121** with the lubricant applicator **50** fairly simplified in its structure.

The present invention is not limited to the above embodiment and can also contain the following contents.

(1) Although the copier is taken as an example of the image forming apparatus **10** employing the lubricant applicator **50** in the above embodiment, the image forming apparatus **10** may be a printer or a facsimile machine without being limited to the copier.

(2) Although the side sealing members **51** are made of the acrylic pile sealing materials in the above embodiment, nonwoven fabrics, sponges, felt materials, foamable synthetic resins or the like may be used instead of the acrylic pile sealing materials.

(3) In the above embodiment, the lubricants **52** are embedded into the mount holes **512** of the side sealing members **51**.

Instead, the lubricants **52** may be arranged on upstream ends of the side sealing members **51** in the rotating direction of the photoconductive drum **121**, i.e. on the upper edge surfaces of the side sealing members **51**, for example, by bonding.

(4) Although the side sealing members **51** are mounted on the movable brackets **53** in the above embodiment, they may be mounted on the opposite ends of the blade **42** or at specified positions of the housing **30** instead.

(5) Although the charging roller **123***b* is used as the charger **123** in the above embodiment, the circumferential surface of the photoconductive drum **121** may be charged by corona discharge from a charging wire instead.

(6) Although the photoconductive drum **121** is taken as an example of the image bearing member in the above embodiment, the image bearing member may be an endless belt without being limited to the photoconductive drum **121**.

The above specific embodiment mainly embraces inventions having the following constructions.

An image forming apparatus according to one aspect of the present invention includes an image bearing member for bearing a toner image while rotating; a developing device including a developing roller for supplying toner to a surface of the image bearing member and a pair of gap rollers held in contact with opposite end portions of the image bearing member to define a specified gap between the developing roller and the surface of the image bearing member; and a lubricant applicator for applying a lubricant to parts of the opposite end portions of the image bearing member where the gap rollers are in contact.

Here, if the image bearing member is a transfer belt mounted between a pair of rollers, the rotation of the image bearing member is literally a rotation of the transfer belt between the pair of rollers. If the image bearing member is a photoconductive drum, it means a rotation of the photoconductive drum about a drum axis.

According to the above construction, frictional resistance of surfaces of the opposite end portions can be reduced since the lubricant from the lubricant applicator is applied to the opposite end portions of the image bearing member. This not only suppresses the adhesion of foreign matters such as residual toner and nitrogen oxides to these parts, but also makes foreign matters easily peelable even if they adhere. In this way, the presence of foreign matters between the gap rollers held in contact with the opposite end portions and the image bearing member is prevented. Thus, a problem that the toner supply from the developing roller to the image bearing member becomes unstable due to a change of a gap size, thereby causing an image failure, can be prevented from occurring and a stable and proper image forming process can be constantly ensured.

In the above construction, the pair of gap rollers may be so mounted on the opposite ends of the developing roller as to be coaxial with the developing roller. According to this construction, the specified gap can be stably ensured.

In the above construction, the lubricant is preferably solid at ordinary temperature. According to this construction, the lubricant solid at ordinary temperature is easily handled and is easily applied according to the rotation of the image bearing member simply by holding the solid lubricant in contact with the surface of the image bearing member, wherefore the structure of the lubricant applicator can be simplified.

In the above construction, the lubricant applicator preferably includes a pair of side sealing members for sealing toner leakage by being respectively held in sliding contact with the surfaces of the opposite end portions of the image bearing member and retaining lubricants while holding lubricants in contact with the surfaces of the opposite end portions of the image bearing member. According to this construction, the lubricants can be retained utilizing the sealing members for sealing the toner leakage and it is not necessary to separately provide a retaining member.

In this case, it is preferable that the image bearing member is a photoconductive drum; and that each sealing member includes an arcuate edge surface extending along the outer circumferential surface of the photoconductive drum and a mount hole which is perforated in the arcuate edge surface and into which the lubricant is to be fitted. According to this construction, since the lubricants are arranged on the arcuate edge surfaces extending along the outer circumferential surface of the photoconductive drum, they can be stably applied to the opposite end portions of the photoconductive drum.

The lubricant applicator preferably further includes biasing members for biasing the pair of sealing members toward the image bearing member. According to this construction, the lubricant is applied to the surface of the image bearing member as the image bearing member is rotated since the respective lubricants retained by the sealing members are pressed against the surfaces of the opposite end portions of the image bearing member by biasing forces of the biasing members. Thus, the lubricants can be reliably applied to the image bearing member with the lubricant applicator fairly simplified in its structure.

An image forming unit according to another aspect of the present invention includes a housing, a photoconductive drum rotatably mounted in the housing, adapted to bear a toner image and including parts at opposite end portions thereof where gap rollers are to be held in contact; and a lubricant applicator for applying a lubricant to parts of the photoconductive drum where the gap rollers are held in contact.

According to this construction, frictional resistance of surfaces of the opposite end portions can be reduced since the lubricant from the lubricant applicator is applied to the opposite end portions of the photoconductive drum. This can prevent the presence of foreign matters between the gap rollers held in contact with the opposite end portions of the photoconductive drum and a surface of the drum.

In this case, if the lubricant used is solid at ordinary temperature, it is easy to handle the lubricant and sufficient only to hold this sold lubricant in contact with the surface of the photoconductive drum and the structure of the lubricant applicator can be simplified.

In the above construction, it is preferable that a cleaning roller to be held in contact with the circumferential surface of the photoconductive drum and a pair of brackets mounted in the housing for rotatably supporting the opposite ends of the cleaning roller are further provided; that the lubricant applicator includes retaining members to be mounted on the brackets; and that the retaining members retain lubricants while holding them in contact with the surfaces of the opposite end portions of the photoconductive drum. According to this construction, the lubricants can be supported via the retaining members, utilizing the brackets for supporting the cleaning roller.

In this case, the retaining members are preferably sealing members for sealing toner leakage by being respectively held in sliding contact with the surfaces of the opposite end portions of the photoconductive drum. According to this construction, the lubricants can be retained utilizing the sealing members for sealing the toner leakage and it is not necessary to separately provide the retaining members.

In the above construction, it is preferable that the brackets are movable brackets movable in a direction toward the photoconductive drum, and that biasing members are further

provided to bias the movable brackets toward the photoconductive drum. According to this construction, the lubricants can be reliably applied to the photoconductive drum since being pressed against the surfaces of the opposite end portions of the photoconductive drum by the biasing members.

As described above, according to the present invention, the presence of foreign matters between the circumferential surface of the image bearing member and the gap rollers can be suppressed. Therefore, the toner can be stably supplied from the developing device to the image bearing member without changing the gap size between the image bearing member and the developing roller and, consequently, the occurrence of an image failure can be prevented.

This application is based on Japanese Patent application serial No. 2008-218229 filed in Japan Patent Office on Aug. 27, 2008, the contents of which are hereby incorporated by reference.

Although the present invention has been fully described by way of example with reference to the accompanying drawings, it is to be understood that various changes and modifications will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention hereinafter defined, they should be construed as being included therein.

What is claimed is:

1. An image forming apparatus, comprising:

a photoconductive drum for bearing a toner image while rotating;

a developing device including a developing roller for supplying toner to a surface of the photoconductive drum and a pair of gap rollers held in contact with opposite end portions of the photoconductive drum to define a specified gap between the developing roller and the surface of the photoconductive drum; and

a lubricant applicator for applying a lubricant to parts of the opposite end portions of the photoconductive drum where the gap rollers are in contact, the lubricant being solid at ordinary temperature, the lubricant applicator including a pair of side sealing members for sealing toner leakage by being respectively held in sliding contact with the surfaces of the opposite end portions of the photoconductive drum, and each of the side sealing members retaining the lubricant while holding the lubricant in contact with each of the surfaces of the opposite end portions of the photoconductive drum, each sealing member including an arcuate edge surface extending along the outer circumferential surface of the photoconductive drum and a mount hole perforated in the arcuate edge surface and into which the lubricant is to be fit.

2. An image forming apparatus according to claim **1**, wherein the pair of gap rollers are so mounted on the opposite ends of the developing roller as to be coaxial with the developing roller.

3. An image forming apparatus according to claim **1**, wherein the lubricant applicator further includes biasing members for biasing the pair of sealing members toward the photoconductive drum.

4. An image forming unit, comprising:

a housing;

a photoconductive drum rotatably mounted in the housing, adapted to bear a toner image and including parts at opposite end portions thereof where gap rollers are to be held in contact;

a cleaning roller to be held in contact with the circumferential surface of the photoconductive drum;

a pair of brackets mounted in the housing for rotatably supporting the opposite ends of the cleaning roller; and

a lubricant applicator for applying a lubricant to parts of the photoconductive drum where the gap rollers are to be held in contact, the lubricant being solid at ordinary temperature, the lubricant applicator including retaining members to be mounted on the brackets, and each of the retaining members retaining the lubricant while holding the lubricant in contact with each of the surfaces of the opposite end portions of the photoconductive drum.

5. An image forming unit according to claim **4**, wherein the retaining members are sealing members for sealing toner leakage by being respectively held in sliding contact with the surfaces of the opposite end portions of the photoconductive drum.

6. An image forming unit according to claim **4**, wherein:

the brackets are movable brackets movable in a direction toward the photoconductive drum; and

the image forming unit further comprises biasing members for biasing the movable brackets toward the photoconductive drum.

7. An image forming apparatus, comprising:

an image bearing member for bearing a toner image while rotating;

a developing device including a developing roller for supplying toner to a surface of the image bearing member and a pair of gap rollers held in contact with opposite end portions of the image bearing member to define a specified gap between the developing roller and the surface of the image bearing member; and

a lubricant applicator for applying a lubricant to parts of the opposite end portions of the image bearing member where the gap rollers are in contact, the lubricant being solid at ordinary temperature, the lubricant applicator including a pair of side sealing members for sealing toner leakage by being respectively held in sliding contact with the surfaces of the opposite end portions of the image bearing member, the lubricant applicator further including biasing members for biasing the pair of sealing members toward the image bearing member, the side sealing members retaining the lubricant while holding the lubricant in contact with each of the surfaces of the opposite end portions of the image bearing member.

8. An image forming apparatus according to claim **7**, wherein the pair of gap rollers are so mounted on the opposite ends of the developing roller as to be coaxial with the developing roller.

9. An image forming apparatus according to claim **7**, wherein:

the image bearing member is a photoconductive drum; and

each sealing member includes an arcuate edge surface extending along the outer circumferential surface of the photoconductive drum and a mount hole which is perforated in the arcuate edge surface and into which the lubricant is to be fit.

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